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as possible. Extreme forms, intermediate forms, depauperate forms, all contribute to the series of which the species is the unit of aggregation. Subspecies, varieties, forms, may be necessary, but these will readily fall into their proper places when the specific type is once understood. The dimorphism which every species exhibits, and which is more apparent in some than in others is only to be apprehended by a close study of the intermediate forms. From a taxonomic standpoint the recognition of these dimorphic tendencies is most important, as they are the marks by which the evolution of the type from its lower to its higher forms is shown.

In conclusion allow me to say that it is to be hoped that when this bloodless nomenclatorial war is over and when musty tomes and rotten types have done their worst and when personal aggrandizement has given way to the claims of science, more time will be found for the study of the making and the delimitation of species. Until that time it is to be feared that many a budding bryologist, full of life and hope, will be nipped by the frosts of many discouragements and driven to other fields in which more satisfactory results await less exacting labors.

Rosemont, New Jersey.

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## HOW TO COLLECT AND STUDY LICHENS.

BRUCE FINK.

Presented at the meeting of the Sullivant Moss Chapter, Philadelphia, Pa., Dec. 31, 1904.

### Introductory.

It is a very real pleasure to the writer to be able to contribute to the meeting of the "Moss Chapter" something which he hopes may prove more or less interesting and suggestive. It was his privilege to be present at the meeting at Columbus, where the beginnings of the organization were made, and that meeting was so thoroughly enjoyable and instructive that he feels more keenly the loss at not being able to be at the present one. At the Columbus meeting, he expressed regrets that the lichenists could not have a similar society; but since that time both the bryologists and the mycologists have appeared to be so willing to give us room that we hardly feel the need of any separate organization. Especially safe is it to state that every American worker in lichenology feels grateful to the "Moss Chapter" for opening the pages of *THE BRYOLOGIST* for our articles on lichens. The work done there is already bearing fruit, and if the present writer can, by sending a paper to this meeting, aid those who have shown an interest in us and our work on the lichens, he will at the same time serve his own ends and those of lichenologists generally quite effectually. So to the matter of collecting and studying lichens without further introductory statement, except to say that only a popular statement can be given in the short time.

### Collecting.

Lichens can be collected at any time in the year, but many of them are more likely to show the spore characters better when collected in the fall. They may be collected also on any kind of a day, but more effective work will be done on pleasant days, while many of the minute forms are more easily detected when damp and therefore brighter. The beginner will find

the more conspicuous foliose and fruticose species first, and will be very likely to begin with the lichens of the trees. After finding a few of the most conspicuous forms, he will think that he is nearly done, and yet every time he goes over the same ground something new will appear. This is the uniform experience, and even the most keen-eyed lichenist finds much of interest after he has been over a limited area several times. The difference between him and the beginner is that he knows from experience that he does not detect all the first few times over a spot; while the beginner has to learn this, little realizing how few of the many species he sees at first and how poorly he distinguishes differences in lichens, at first thinking that three or four forms are all one, when perhaps they do not even belong to the same genus. But careful study will soon begin to improve the powers of observation, and the work will grow and the interest increase day by day. In continuing to work on a small area till it has been looked over a dozen times or more, one should attempt to find every substratum that might bear lichens and take into account all the varied conditions of light, shade, and moisture, which cause so much of the variation in species. Look carefully on old dying trees, trees in good condition but old with rough bark, and younger trees with smooth bark, for rocks in shade and rocks exposed to sunlight, the outcrops and the boulders and for shaded and exposed earth. Then look for any species of lichens that seem to prefer a particular genus or species of tree or a particular kind of rock or earth. And when all this is done in an average region, the beginner should be able to find from 100 to 150 lichen species and varieties within five miles of his home, while in some localities such work carried on for two or three years should give the student more than 200 lichens.

### **Collecting Outfit.**

But before the first trip is made the student will want to know what to carry with him on a collecting trip. A good knife is needed to take the lichens from the trees with as little of the bark as possible, and a geologist's hammer and a good cold chisel, especially tempered for the rocks to be chipped, to get the rock lichens with as little of the rock as possible. Then a hand lens is needed to enable one to detect differences in lichens in the field so as to know as far as possible whether he is duplicating too much. With the lens one soon comes to detect differences in both surfaces of the larger thalli, the nature of the exciple and disk, the upper surface of crustose lichens and many apparently slight microscopic differences in minute lichens, which might otherwise be thought to be the same in the field when they do not even belong to the same genus. A bag, basket or vasculum must be carried to contain the specimens, and a lot of paper or envelopes so that each kind of lichen may be wrapped separately as it is collected. Then there must be a pen or pencil so that careful notes may be placed on each envelope or in each packet, showing the date of collecting, the name of the substratum and the surrounding conditions as to light, moisture and shade, or any other data that may be desirable in a particular instance. A sponge is sometimes very handy for moistening certain lichens in dry weather so that they may be easily separated from the substratum, and a small bottle of water may

easily be carried to wet the sponge from time to time. Delicate specimens from rocks or earth should be wrapped separately in any old paper to prevent breaking or abrasion.

### **Where to Collect.**

Go to some well wooded area if such is at hand and begin work as already suggested on the large foliose lichens of the trees. Do not go on a long tramp, but as soon as you are in the woods, collect the lichens that are growing all around. It is too common an error to start on a long tramp, and many a collector walks for miles and goes by the lichens on every side because he thinks he will find something better just ahead. The result is a long walk and few specimens. If woods are not at hand and rocks are, they will serve for a beginning but beginners always make bad work of chipping rocks. Do not carry home a cord of rocks; but get pieces just large enough so as to get the lichen wanted complete, or at least enough of it to show the border of the thallas on one side. In many areas, especially in the pineries, one may well begin with the earth lichens. They are there easy to find and collect, but often require a good deal of care at home. If so unfortunate as not to live near woods or rocks, lichens may still be found on old fences and on trees planted along roads and in yards, etc. In the woods, be sure to examine old logs and stumps, corticate and decorticate, sound and rotten, standing, erect and prostrate. In examining boulders and pebbles, look at all sizes; and on the larger ones expect different species near the ground from those growing at the top where there is less of moisture. As stated in a preceding paragraph, look out for different kinds of trees, rocks and earth. Uninhabited and undisturbed wooded regions are the best places in the world for lichens, but there is no place where they may not be found, for they occur even on the prairies and about the large cities.

### **Aids at Home.**

We will suppose that the first collection is made. It matters not what the species are for the first time, but they are very probably the most common of lichens, just as they should be. Perhaps the specimens are small and fragmentary, but the collector will soon learn by experience that it pays to get good material, and if he is to exchange later on or send away for determination, to get it in abundance. No warning will have much weight till he has run out of some rare material in exchange, or has frequently been told by one of more experience that his material sent is too fragmentary for determination. But leaving this for the present, what is needed at home in order to work effectively? If possible there should be a table permanently placed for work. On it should be a microscope, magnifying at least 550 diameters, a good sharp razor for cutting sections of fruit and thalli, pith in which to cut the sections, a small bottle of water and another of potassium hydrate, slides and cover glasses, an eye-piece micrometer for measuring the size of spores, and some volume which contains descriptions of all the common lichens. The sections are to be cut in the elder pith with a very sharp razor, and they must be thin enough so as to be more or less transparent under the microscope. These sections may be mounted directly in water, and in most instances no other solution is needed. However, if the sections

are not clear, the water may be drawn out gradually and replaced by the potassium hydrate, placing a drop of this solution at one side of the cover glass and a bit of absorbent paper at the other side to take up the water. Filter paper serves this purpose best. If the asci, spores and paraphyses do not come out distinctly with this treatment, the section may be carefully crushed after the character and color of the exciple or exciples, the hypothecium and the hymenium are all studied. Then if still unsuccessful, some stain may be applied. Iodine solution will serve to differentiate between the asci and the paraphyses as it stains them differently and often brings out the branching of the paraphyses beautifully. Some experience will enable the beginner to get just the best strength of iodine solution, but one grain of iodine, three grains of iodine of potassium and one of pure water makes a very good combination. The sections are almost sure to be too thick at first, but experience will remedy this difficulty. The razor should be sharp enough to cut a section of the pith thin enough so that it will float in the air, and then the section of the lichen or lichen apothecium will be so thin that one will often need to place his slide on white paper in order to see the sections, which are to be transferred from the razor to the slide by means of a small camel's hair or other similar brush. To insert the material to be sectioned into the pith, cut a slit through a radius of the pith from one end down an inch or more. Then taking a portion of thallus or fruit 2 or 3 mm. across, insert into the opening in such away as to be able to cut in the direction desired. If the fruit is larger than 3 mm. in diameter, it is still best not to try to cut larger sections, but an edge of the apothecium is to be included in the section, and it is permissible to section one whole, cutting through a diameter so as to see the structure. However, this section is likely to be of little use for any careful work. Do not attempt to cut all the way across the pith at every cut, but rather to get very thin sections of small portions of the upper surface of the pith, including a section of part or all of the lichen structure to be studied. This procedure will soon render the upper surface of the pith uneven, when a complete section may be taken to level it. Many beginners will not think all of this advice necessary; but all will appreciate it after a few trials, and will wish it were possible to make matters much plainer than can possibly be done in any written directions. As to the razor, it must be of good quality, not too thick, and is better if hollow ground on one side only. Then keep it sharp, sharp! sharp!! Do not sharpen a moment and then resume work with a contented air, but see if it will readily cut sections of pith that are scarcely visible when floating in the air. If not, it is not in condition for cutting sections of lichens. Then there should be always at hand on the table a metric rule, for the larger measurements of thalli and fruits, which of course can not be made with the micrometer.

There are many other things that might be stated, but too much is confusing to the beginner. At first, throw away unfruited specimens, unless you have material with which to compare, but later, after you know something of lichen species and think you have a sterile one different from any of the fertile ones, determine it or sent to an expert. If you have no microscope, you can still do some good work with fifty or one hundred authentic speci-

mens with which to compare and the series of articles published in the *BRYOLOGIST* by Mrs. Harris. The beginner will not need foreign literature, but the books written by Tuckerman, Schneider and Willey will be found helpful if they can be obtained. As you gain in experience, difficulties will clear up, and you will find ways of your own and perhaps better ones than some of those suggested above, for no two people work just alike. At least do not collect without attempting to determine as best you can. Send specimens to an expert with your determinations stated on every envelope, even if you are no farther than the genus or even the family. You must do this for the sake of the satisfaction of it and the strength that it will give.

### **The Study at Home.**

But given this table and apparatus and some directions regarding use. Just what shall be studied? Regarding the thallus there must be careful observation of form, size, color, method of attachment and general relation to the substratum, nature of the surface as to whether smooth, wrinkled, chinky; areolate, verrucose, etc., the margin as to whether entire, wavy, or lobed, etc., and finally the cross-section must be made and carefully studied. Then turning attention to the fruit, the general form and size must be carefully noted, the form and color of the disk, the nature and duration of the exciple or exciples, and the manner of attachment of the fruit to the thallus. Then the sections may be resorted to in order to ascertain the nature of the exciple, the hypothecium, the paraphyses, the asci, and the spores. And, finally, it will be found to be an excellent exercise to attempt to write a description of a lichen occasionally bringing out all the points observed. After a few descriptions have been written, those in manuals of lichens will mean more to the student, for they will not appear so vague as soon as the powers of observation and discrimination are thoroughly developed. Sometimes one can put some special "ear mark" into a description, but often two species are somewhat different in a number of points, but not very much so in any one particular respect. In such instances, the attempt to show the special "ear mark" will be a failure, and the decision between the two species may be by no means easy for the most competent student of lichens. The beginner must always see the spores in the asci, as he is otherwise very likely to get the spores of some other lichen occasionally and make a stupid failure in the determination. And the student must be warned not to expect to find sections like many of the drawings in some manuals of lichenology. Many of these figures are diagrams, which show what might be seen in ideal sections. They serve their purpose, but the student will usually have to be content with seeing things much less distinctly. Finally, after the beginner has done his best, he will often have to be satisfied with tracing his plant to the genus or family rather than to the species; but he need not be discouraged at this, for experience will make him more and more able to determine species. Every manual of lichens has some peculiarities that need explanation. And perhaps the uses of the terms *pale* and *cloudy*, as applied to the hymenium and the hypothecium in the descriptions issued by the present writer, need special explanation. In ordinary sections the lightest colored areas in these tissues seem whitish, whereas, if the sections were thinner,

they might appear perfectly hyaline. These areas have been called pale. Then in some other lichens similar sections are somewhat denser in these areas so that in sections of ordinary thickness there is a darkish cast that really appears like the color of clouds. Then plainly enough, a section will tend toward a pale appearance if thin, and is more likely to be cloudy if thick. And in the interpretations of these and all other colors seen in sections, some allowance must be made for the thickness of the section. Of all the diagnostic characters given in descriptions, perhaps those regarding the paraphyses have least value. The common statement is about thus, paraphyses simple or rarely branched, commonly enlarged and brownish toward the apex. This answers for the great majority of lichens with little modification but when the statement varies considerably from this form, the paraphyses are of more consequence in determination. Also, it should be said that in measurements, macroscopic and microscopic, there is usually no special effort made to reach the rarest extremes in sizes. So the student need not be surprised at finding occasionally larger or smaller measurements than those given. However, the extreme sizes must not vary greatly from those of the manual used.

### **The Herbarium.**

Specimens once determined should be carefully dried so as to avoid moulding, and the larger ones are to be pressed in the same way that higher plants are pressed, placing the specimens in the press, not soaked with water, but just damp enough to press well. The crustose and closely adnate foliose species seldom need pressing. Earth containing small foliose or crustose species must be saturated with mucilage, which will keep it from crumbling in the herbarium and destroying the specimens. All but the rock specimens keep well in the ordinary herbarium envelopes, and even they are often kept in the envelopes also. But if one is not very careful not to get large pieces of rock, it is usually necessary to resort to stronger and larger envelopes or pasteboard boxes for these rock lichens. Delicate specimens as *Caliciums*, and members of some other genera had better be glued to the bottom of small boxes in such a manner that the delicate lichens will be out of contact with anything else than the substratum on which they grew. The envelopes may be mounted on ordinary herbarium paper, but brown paper is very commonly used by the lichenists of Europe, both for envelopes and mounting paper. This paper does not show dirt as does the white paper. Many paste all specimens to paper if removed from the substratum; but if this is done, part of the material must be placed ventral side upward so that both sides of the thallus may be seen. This method helps to prevent breaking the brittle thalli, but interferes somewhat with the study of the specimens. All specimens in the herbarium must contain careful data such as those suggested to be taken in the field. Finally, it is not possible that a short paper should contain all the suggestions that are valuable in the collecting and study of lichens, but it is hoped that those given may enable the members of the chapter and others to work somewhat intelligently, while gaining that experience which is more valuable than any directions that can be given.

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